CLAIMS

What is claimed is:

1. A process for producing substantially round polymer particles comprising the steps of:

(i) forming a mixture comprising polymer pellets, an aqueous medium and at least one surfactant;

(ii) heating said mixture under plug flow and plug free heating conditions;

(iii) shearing heated mixture; and

(iv) cooling sheared mixture under plug free cooling conditions to produce said substantially round polymer particles.

2. The process of claim 1 wherein said surfactant is blended in said polymer pellets.

3. The process of claim 2 further comprising adding additional portion of said surfactant to said aqueous medium in said step (i) or adding another surfactant to said aqueous medium in said step (i).

4. The process of claim 1 wherein said surfactant is added to said aqueous medium in said step (i).

5. The process of claim 1 or 2 wherein said polymer pellets comprise a thermosetting polymer.

6. The process of claim 1 wherein said polymer pellets comprise a thermosetting polymer and a crosslinking agent.

7. The process of claim 1 wherein said polymer pellets comprise a thermosetting polymer, a crosslinking agent, said surfactant, a pigment and a catalyst.

8. The process of claim 1 or 2 wherein said polymer pellets comprise a thermoplastic polymer.

9. The process of claim 1 wherein said polymer pellets comprise a thermoplastic polymer, said surfactant and a pigment.

10. The process of claim 5 further comprising dispersing or solubilizing a crosslinking agent in said steps (i), (ii) or (iii).

11. The process of claim 5 further comprising dispersing or solubilizing a catalyst in said steps (i), (ii) or (iii).

12. The process of claim 5 wherein said polymer pellets comprise a substantially uncrosslinked blend of said thermosetting polymer and a crosslinking agent.

13. The process of claim 12 further comprising dispersing or solubilizing a catalyst in said steps (i), (ii) or (iii).

14. The process of claim 1 wherein said particles are cooled under plug flow cooling conditions.

15. The process of claim 1 further comprising isolating said polymer particles from said aqueous medium.

16. The process of claim 15 further comprising rinsing said isolated polymer particles with water to remove said surfactant adhered to said polymer particles.

17. The process of claim 1 further comprising reducing the concentration of said surfactant in said mixture by adding water to said medium.

18. The process of claim 1 wherein said heating step comprises injecting steam through a plurality of heating zones positioned on said means for heating.

19. The process of claim 1 wherein said plug flow heating conditions are attained by:

i) maintaining the Reynolds Number of said mixture passing through said means for heating at about 2,000 to 500,000; and

ii) maintaining the transportation velocity of said mixture in said means for heating at or above the Durand's minimum transportation velocity expressed by the following equation:

$$V_{MH} = F_1\left[2gD_H\left(\frac{\Delta\rho}{\rho_{medium}}\right)\right]^{0.5}$$

where $\mathbf{V_{MH}}$ is minimum transportation velocity of the mixture, F_1 is an empirically derived constant that depends on the size of the polymer pellet being conveyed, g is the acceleration due to gravity, D_H is the inner diameter of a heating section of said means for heating, $\Delta\rho$ is the absolute value of the difference between the densities of the polymer pellets and the aqueous medium and ρ_{medium} is the density of the aqueous medium.

20. The process of claim 14 wherein said plug flow cooling conditions are attained by:

i) maintaining the Reynolds Number of said mixture passing through said means for cooling at about 2,000 to 500,000; and

ii) maintaining the transportation velocity of said polymer particles in said means for cooling at or above the Durand's minimum transportation velocity expressed by the following equation:

$$V_{MC} = F_2\left[2gD_C\left(\frac{\Delta\rho}{\rho_{medium}}\right)\right]^{0.5}$$

where $\mathbf{V_{MC}}$ is minimum transportation velocity of the mixture, F_2 is an empirically derived constant that depends on the size of the polymer pellet being conveyed, g is the acceleration due to gravity, D_C is the inner diameter of a cooling passage of said means for cooling, $\Delta\rho$ is the absolute value of the difference between the densities of the polymer pellets and the

aqueous medium and ρ_{medium} is the density of the aqueous medium.

21. The process of claim 19 or 20 further comprising reducing operating pressure of cooled mixture exiting from said means for cooling to atmospheric pressure.

22. The process of claim 21 wherein said operating pressure is reduced to atmospheric pressure by passing said cooled mixture through a capillary tube.

23. The process of claim 21 wherein said operating pressure is reduced to atmospheric pressure by applying an opposing pressure provided by a pressure let down pump against said cooled mixture exiting from said means for cooling.

24. Substantially round polymer particles made in accordance with the process of claim 1.

25. A process for producing substantially round polymer particles comprising the steps of:

(i) forming a mixture comprising polymer pellets, an aqueous medium and at least one surfactant;

(ii) heating said mixture in means for heating under plug flow and plug free heating conditions to melt said pellets;

(iii) shearing said melted pellets in said heated mixture; and

(iv) cooling said sheared mixture in means for cooling under plug free cooling conditions to produce said polymer particles.

26 A device for producing substantially round polymer particles comprising:

(i) means for forming a mixture of polymer pellets, an aqueous medium and at least one surfactant;

(ii) means for heating said mixture under plug flow and plug free heating conditions;

(iii) means for shearing said heated mixture; and

(iv) means for cooling said sheared mixture under plug free cooling conditions.

27. The device of claim 26 further comprising means for isolating said polymer particles from said aqueous medium.

28. The device of claim 26 wherein a capillary tube is connected to said means for cooling to reduce operating pressure in said means for cooling to atmospheric pressure.

29. The device of claim 28 wherein a pressure let down pump is connected to said means for cooling to reduce operating pressure in said means for cooling to atmospheric pressure by applying an opposing pressure against cooled mixture exiting from said means for cooling.

30. The device of claim 26 wherein said means for heating and cooling are substantially free from obstruction to attain said plug free conditions.

31. The device of claim 26 wherein said polymer pellets comprise a substantially uncrosslinked blend of a thermosetting polymer and a crosslinking agent.

32. The device of claim 31 wherein said means for cooling are adapted to cool said polymer particles in said mixture under plug flow cooling conditions.

33. The device of claim 26 wherein said means for heating comprise a plurality of heating sections interposed with a plurality of heating zones positioned at substantially equidistant intervals.

34. The device of claim 33 wherein said heating zone is provided with at least one injection port.

35. The device of claim 33 wherein said heating zone is provided with at least two injection ports.

36. The device of claim 35 wherein said injection ports are positioned in an opposing relationship to one another.

37. The device of claim 26 wherein said heating zone is provided with at least one drain port for removing excess amount of steam supplied to said heating zone.

38. The device of claim 26 wherein said means for cooling is an elongated cooling passage surrounded by a cooling jacket.